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ABSTRACT

A study investigated children's understanding (3-, 6-, 9-, and 12-year-olds) of the different levels of meaning of the cognitive verb "know" as defined by the abstractness and conceptual difficulty hierarchy of W. S. Hall, E. K. Scholnick, and A. T. Hughes. Results indicated that cognitive verb knowledge increased with development and that certain low levels of meaning were mastered before certain high levels of meaning irrespective of the medium of presentation: video-taped "skits" and audiotaped "stories." However, children developed an understanding of low levels of meaning at a more rapid rate than high levels of meaning. This resulted in a more differentiated and hierarchical cognitive verb knowledge in older children. Finally, results indicated that the audiotaped stories were more difficult than the videotaped skits, and that both tasks were significantly correlated with a standardized vocabulary measure for all ages except the 3-year-olds. (Contains 44 references, and 2 tables and 1 figure of data. Appendixes present the setting, tester prompts, and "correct" answers for the 6 levels of meaning for 6 videotaped and 6 audiotaped stories.) (Author/RS)

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A Hierarchical Model of the Mental State Verbs

James R. Booth
William S. Hall
University of Maryland College Park

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READING RESEARCH REPORT NO. 42
Summer 1995

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NRRC - University of Georgia
318 Aderhold
University of Georgia
Athens, Georgia 30602-7125
(706) 542-3674 Fax: (706) 542-3678
INTERNET: NRRC@uga.cc.uga.edu

NRRC - University of Maryland College Park
3216 J. M. Patterson Building
University of Maryland
College Park, Maryland 20742
(301) 405-8035 Fax: (301) 314-9625
INTERNET: NRRC@umail.umd.edu

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National Reading Research Center
318 Aderhold Hall
University of Georgia
Athens, GA 30602-7125
(706) 542-3674

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National Reading Research Center
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University of Maryland
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About the Authors

James R. Booth is a post-doctoral fellow in the Department of Psychology at Carnegie Mellon University. He was a graduate student in Developmental Psychology at the University of Maryland College Park when this research was conducted.

William S. Hall is a Professor of Developmental Psychology and Chair of the Department of Psychology at the University of Maryland College Park. Please address all correspondence to William S. Hall, Department of Psychology, University of Maryland, College Park, MD 20742.

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A Hierarchical Model of the Mental State Verbs

James R. Booth
William S. Hall
University of Maryland College Park

Abstract. *This study investigated children's understanding (3-, 6-, 9-, and 12-year-olds) of the different levels of meaning of the cognitive verb* know *as defined by the Hall, Scholnick, and Hughes (1987) abstractness and conceptual difficulty hierarchy. We found that cognitive verb knowledge increased with development and that certain low levels of meaning were mastered before certain high levels of meaning irrespective of the medium of presentation: videotaped "skits" and audiotaped "stories." However, children developed an understanding of low levels of meaning at a more rapid rate than high levels of meaning. This resulted in a more differentiated and hierarchical cognitive verb knowledge in older children. Finally, we found that the audiotaped stories were more difficult than the videotaped skits, and that both tasks were significantly correlated with a standardized vocabulary measure for all ages except the 3-year-olds. The implications of this study and others for a model of the cognitive verb lexicon are discussed.*

The development of word knowledge in children is essential for high-level text understanding (e.g., Stahl, Hare, Sinatra, & Gregory, 1991), and research conclusively shows that early literacy experiences in school as well as in the home affect children's development of this word knowledge (e.g., Heath, 1991; Sulzby & Teale, 1991). For example, the amount of exposure to print has a strong influence on reading efficiency (Stanovich & Cunningham, 1992). We have argued elsewhere that acquisition of a certain domain of words, mental state verbs, appears to be essentially involved in the interpretation of text (Booth & Hall, 1994b, 1994c).

Most research on lexical development has concentrated on the child's acquisition of words that refer to objects, actions, and events (Clark, 1983). Comparatively little research has been conducted on the child's acquisition of words that refer to states such as *cognitive verbs*. Moreover, most research that has been conducted has investigated the child's first understanding of these cognitive verbs. Only recently has research been conducted on older children's and adult's understanding of these words (cf. Astington & Olson, 1990; Booth & Hall, 1994a, 1994c; Fabricius, Schwanenflugel, Kyllonen, Barclay, & Denton, 1989; Schwanenflugel, Fabricius, & Alexander, 1994; Schwanenflugel, Fabricius, Noyes, Bigler, & Alexander, 1994). Hall and Nagy (1986) have defined cognitive verbs as those words for which the internal state component of the meaning is the primary or focal compo-

nent. Most internal state words are verbs with the experiencer as the subject (e.g., "John *knows* the answer").

Studies of cognitive verbs are important because theories of lexical acquisition and knowledge representation based on studies of objects may not extend to the acquisition of cognitive verbs (Carey, 1982). Verbs differ from nouns in many ways (Tomasello & Merriman, 1995). For example, verbs have more elaborate syntactic information associated with them. Verbs represent information about the number of arguments (e.g., subject, object, and oblique) and which roles are carried by these arguments (e.g., agent, patient, and location). Furthermore, the categories for verbs are less coherent partially because the mental or physical sequence labeled by verbs may differ depending on the object or the situation (e.g., *knowing* a familiar face versus *knowing* how to juggle). The acquisition of cognitive verbs is also important to study because their acquisition is related to the development of a "theory of mind."

In order for children to be accredited with a "theory of mind," they must be able to explain and predict their own mental states as well as the mental states of others (Wellman, 1990). The study of cognitive verbs is very important for our understanding of children's "theory of mind" because these verbs label all facets of their mental worlds. For example, the experience associated with *recalling* is very different than the experience associated with *recognizing*. Since cognitive verbs make fine-grained distinctions between different mental states, this may encourage children to compare and contrast the processes that they designate and the distinctions that they represent (Hall, Scholnick, & Hughes, 1987). Indeed, children may use cognitive verbs to monitor, transform, organize, and interpret their internal mental states (Scholnick & Hall, 1991). Therefore, understanding the acquisition of cognitive verbs may provide the researcher with a window to the inner workings of the developing mind.

The literature contains a growing number of investigations on children's comprehension of the distinction among different cognitive verbs (cf. Abbeduto & Rosenberg, 1985; Beeghly, Bretherton, & Mervis, 1986; Johnson & Maratsos, 1977; Macnamara, Baker, & Olson, 1976; Moore, Bryant, & Furrow, 1990; Olson & Astington, 1990; Scholnick, 1987; Shatz, Wellman, & Silber, 1983; Wellman & Estes, 1987). The evidence points to the fact that children begin to distinguish between different aspects of some types of internal state words by age 3. However, this evidence is incomplete, because most of the previous studies assume that cognitive verbs have only one meaning. Some cognitive verbs may have only one primary meaning (e.g., *recognize* and *recall*), but other cognitive verbs have several meanings that characterize distinct mental processes. For example, "I *know* that face" refers to a recognition, but "*knowing* is different from doing" refers to a metacognitive description. Studying the acquisition of polysemous verbs like *know*, *think*, and *believe* is important because these are the most frequently used cognitive verbs in the young child's lexicon (Shatz et al., 1983). Less frequent words, like *perceive* and *comprehend*, that label specific levels of meaning are more

appropriate in investigations of older children (Booth & Hall, 1994c).

Since cognitive verbs label all aspects of internal mental states, different cognitive verbs or the various meanings of one cognitive verb may have different developmental trajectories (Astington & Gopnik, 1991). Indeed, there is emerging evidence that cognitive verbs may be organized along an informational dimension. One model of the informational dimension is that cognitive verbs are organized hierarchically according to their increasing conceptual difficulty and abstractness. Hall et al. (1987) suggested that internal state words are used to represent a continuum of internal processing: (1) registering an experience perceptually; (2) determining familiarity of an experience; (3) embedding an experience in a factual network; (4) understanding the interconnections among concepts; (5) commenting on how processing is done; and (6) making explicit one's presuppositions about the experience. They referred to these levels as *perception*, *recognition*, *recall*, *understanding*, *metacognition*, and *evaluation*, respectively.

This hierarchical model was based on child (4½ years) and adult production frequencies in natural speech (Hall, Nagy, & Linn, 1984). Hall et al. (1987) found that, for all cognitive verbs, the higher levels were produced more than the lower levels of meaning, except *recall* and *metacognition* which were produced more than *recognition*. Later, Frank and Hall (1991) dealt with the discrepancies between the data and theory by restructuring the six levels of meaning for the cognitive verb *know*. First, *recognition* and *recall* were combined into the one level, *memory*, because they both refer to the process of remembering. Second, *evaluation* was placed lower in the hierarchy than *metacognition*, because *evaluation* can refer to concrete as well as abstract mental operations, whereas *metacognition* always involves abstract, internal processing. Third, *planning* was added to a highest level in the hierarchy to account for the "assessment of future intention which implies an understanding and integration of past events" (p. 5). This new hierarchy fit the data better: the higher levels were produced more than the lower levels of meaning.

Booth and Hall (1994b, 1994c) then used a multiple choice comprehension measure of the cognates of *think* and *know* to test the Frank and Hall (1991) hierarchy with older children (fifth graders to undergraduates). They found that all significant differences between levels of meaning were in the predicted direction. However, based in part on this study, we altered the hierarchy in three ways. (1) We eliminated *planning* because this level was not reliable in the comprehension study, and because this level was never verbally expressed by adults or children in the Frank and Hall (1991) study. Indeed, both *planning* and *evaluation* involve an assessment of the truth of a prediction or proposition based on previous or current knowledge. (2) We also considered *evaluation* to be at a higher level in the hierarchy than *metacognition*. It is probably more conceptually demanding, for example, to make a truth judgement based on several "facts" than to think about how we remember. (3) We separated the *memory* level into *recognition* and *recall*, because the Frank and Hall (1991) analysis was based only on production

frequencies (see Clark, 1983). Moreover, the phenomenological experience associated with recognizing something is very different from recalling something. In sum, the six levels of meaning in the present investigation can be restated as follows:

(1) *Perception*. The speaker reports the act of perception (e.g., "I heard your story").

(2) *Recognition*. The speaker acknowledges familiarity with some person or concept (e.g., "I know that face").

(3) *Recall*. The speaker refers to factual information that s/he remembers (e.g., "I know his phone number").

(4) *Understanding*. The speaker refers to a conceptual framework or reasoning (e.g., "I know why he did that").

(5) *Metacognition*. The speaker focuses on discussing the awareness of mental acts (e.g., "Pretending can be fun").

(6) *Evaluation*. The speaker refers to attitudes and beliefs about the truth of statements (e.g., "He guessed the answer, but I know it").

This hierarchy is supported by recent studies that have asked adults and children to judge the degree of relation between many cognitive verbs (Schwanenflugel, Fabricius, & Alexander, 1994; Schwanenflugel, Fabricius, Noyes et al., 1994). Using multidimensional scaling, these studies have found that cognitive verbs vary along a dimension they called "information processing" from input functions (e.g., *notice* and *see*) to processing and memory functions (e.g., *remember* and *figure out*), and to output functions (e.g., *decide* and *explain*). A comparison of this model and the previously mentioned one reveals that they are in fact very similar even though very different methodologies were employed in order to test them.

Other evidence suggests that cognitive verbs are organized according to an informational or conceptual difficulty metric. Very young children often equate *knowing* with *seeing* or *doing*. They assume, for example, that if someone sees something s/he automatically knows it. When children are asked how they know something, they will often say, "I *saw* it" (Fabricius & Cavalier, 1989). Another study found that 4- and 5-year-old children could only distinguish accurately between *know* and *guess* when they had access to the outcome of the subject's behavior (i.e., they successfully or unsuccessfully found a hidden object), whereas the 6- and 7-year-old children could distinguish between *know* and *guess* when they were given only verbal information regarding the location of the hidden objects (Miscione, Marvin, O'Brien, & Greenberg, 1978). Taken together, these results suggest that younger children are having trouble differentiating between mental acts, such as *knowing*, and physical acts, such as *seeing* and *doing* (see also Johnson & Wellman, 1980; Wellman & Johnson, 1979). In contrast, older children realize that in order to know something you may have to mentally manipulate or rehearse the information. When older children are asked

how they know something, they will often answer, "I *pictured* it in my head" (Fabricius & Cavalier, 1989). Finally, children come to realize that the mind is an interpreter, evaluator, and constructor of knowledge and that access to quality information determines whether a person knows something (Montgomery, 1992).

Specific Aims

There is converging evidence that cognitive verbs vary along a conceptual or informational dimension and that children first acquire cognitive verbs that are less cognitively demanding (Booth & Hall, 1994c; Schwanenflugel, Fabricius, & Alexander, 1994). The primary goal of the present investigation was to provide further empirical support for this hierarchical model using a comprehension measure with a wide age-range of children (3- to 12-year-olds). We expected that cognitive verb knowledge would increase significantly with age, but that the low levels of meaning of the cognitive verb *know* would be acquired earlier than the high levels of meaning. However, since low levels of meaning (i.e., *perception*, *recognition*, *recall*, and *understanding*) are less abstract and conceptually demanding, we expected their acquisition would be more rapid than the high levels of meaning (i.e., *metacognition* and *evaluation*). Similarly, we expected low scores and very few differences between the six levels of meaning for the younger children, because 3-year-olds have been shown to understand very few, if any, meanings of *know* and other cognitive verbs (Miscione et al., 1978; Johnson & Wellman, 1980). We did expect more differentiation between the six levels of meaning for the older children, because they are developing a hierarchical model of the cognitive verb lexicon.

Our second expectation was that cognitive verb knowledge would be highly correlated with standardized vocabulary measures. These findings would confirm other studies that have found a strong correlation between cognitive verb knowledge and vocabulary and reading comprehension in children (Olson & Torrance, 1986; 1987). We have argued earlier that cognitive verb knowledge may provide a unique content knowledge that facilitates efficient vocabulary acquisition and text comprehension because, for example, to determine what a character *thinks* or *knows* may be essential for interpreting their past, present, and future motives (Booth & Hall, 1994c).

Method

Subjects

Participants were children at four mean ages recruited through day-care centers and elementary schools in the metropolitan Washington, DC, area. There were 19 three-year-olds (M = 3.96; SD = .30), 21 six-year-olds (M = 6.15; SD = .30), 25 nine-year-olds (M = 8.43; SD = .56), and 17 twelve-year-olds (M = 11.69; SD = .49). All children had English as a first language. All children who volunteered completed all aspects of the study.

Materials

The children were administered 18 videotaped skits and 3 out of 6 audiotaped stories.

The 18 videotaped skits involved interactions among two hand-held puppets. Three skits represented each of the six levels of meaning of the cognitive verb *know* according to the Hall et al. (1987) hierarchy. The skits were balanced so that two skits at each level of meaning were correctly answered in the affirmative, while one was correctly answered by a negative response. The order of presentation of the videotaped skits was the same for all children. There were three blocks of six skits, each ascending in level of meaning (from *perception* to *evaluation*). Each block began with low level of meaning and ended with high level of meaning so as not to frustrate the children with continued unsuccessful performance. The six audiotaped stories also characterized the six levels of meaning in the Hall et al. (1987) hierarchy. Each story was accompanied by a six-page booklet of stick figure drawings. Half of the children in each age group were administered the same three (out of six) stories in one of two order conditions: one-two-three or three-two-one. The questions after each story were presented in ascending levels of meaning (from *perception* to *evaluation*). This was so that children were not initially discouraged by unsuccessful performance on the high level of meaning questions, and because the information about low levels of meaning tended to occur in the first half of the story, whereas the information pertaining to high levels of meaning tended to occur in the second half of the story. The setting, tester prompts, and "correct" answers for the six levels of meaning for a selected six of the videotaped skits are in Appendix A, and for a selected two of the audiotaped stories are in Appendix B.

The 3- and 6-year-olds were administered the Peabody Picture Vocabulary Test (PPVT-R). A standardized vocabulary measure was obtained from the school records of the 9- and 12-year-olds.

Design and Procedure

Testing was conducted individually with each child on three separate occasions. On the first occasion, there was a brief familiarization procedure that acquainted the child with the experimenter and with the two puppets that were the characters in the videotaped skits. The puppet in the familiarization procedure and in the skits about which the child was questioned was always matched to the sex of the child. After the presentation of each skit on the television monitor, each child was asked two comprehension questions. The first question required the child to respond yes or no, and the second question required the child to explain why s/he answered yes or no (see Appendix A). All responses were tape-recorded for later scoring.

On the second occasion, the children were administered the audiotaped stories. There was a brief familiarization procedure in which the child and the experimenter talked about their favorite stories. The children then listened to the tape-recorded stories. As with many children's story books, a tone signaled the child that a page in the accompanying book of six pictures should be turned. An experimenter assisted all children to ensure that the pictures and recording were aligned. There were 7-second pauses between the sentences accompanying the six pictures (see

Appendix B). Three stories were administered to each child. Immediately after the presentation of each story, the experimenter asked the child five basic plot questions and six 2-part questions corresponding to the six levels of meaning portrayed in the story. The first part required the child to respond yes or no, and the second part required the child to explain why s/he answered yes or no. The children did not have access to the pictures when answering questions. All responses were tape-recorded for later scoring. We acknowledge a potential order confound because the videotaped stories were always presented first and the audiotaped stories second. This presentation order was necessary, however, so that the children were not initially discouraged by the "harder" audiotaped stories. Indeed, if the audiotaped stories were more conceptually demanding than the videotaped skits, a difference between them would less likely emerge in this presentation order because initial familiarization with the videotaped skits may enhance performance on the audiotaped stories.

The scoring of responses to the videotaped skits and the audiotaped stories consisted of two parts. The first part entailed scoring the yes/no answer. The scores were given as follows: 0 for an incorrect response; 1 for no response (e.g., "I don't know" or a shrug); 2 for an inexact response (e.g., "maybe . . ." or "maybe not . . ."); and 3 for a correct response. Incorrect responses were scored 0 and no response was scored 1, because children who gave an incorrect response actively exhibited their faulty reasoning; children who gave no response could have had either correct or incorrect responses in mind, but due to other factors (e.g., insecurity or shyness) chose not to respond. The second part entailed scoring the explanation of the yes/no response. These scores were given as follows: 0 for an inappropriate explanation; 1 for no explanation (e.g., "I don't know" or a shrug); 2 for an incomplete explanation (e.g., "he just did" or "he just didn't"); and 3 for a complete and an appropriate explanation. If a child had a correct response (3) on the explanation part and the child's yes/no answer was an incorrect response (0) or no response (1), the yes/no part was equated to an inexact response (2). If the child did not have a correct response (3) on the explanation part, the yes/no score was not adjusted.

The following criteria were used for determining whether a response was judged correct (see Appendices A and B). For *perception*, the child had to refer to *knowing* as an act of perceiving something (e.g., touching another person, seeing the wall, or feeling the hot day). For *recognition*, the child had to refer to *knowing* as a judgment of familiarity in the presence of a stimuli (e.g., hearing a voice, seeing a tree house, or taking a short cut to the pool). For *recall*, the child had to refer to *knowing* as remembering factual information in the physical absence of that information (e.g., the movie starting time, the tree house wall used to be intact, or a path to the pool). For *understanding*, the child had to refer to *knowing* as reasoning about or comparing facts to general knowledge (e.g., knowing that air can travel through small holes, realizing that the tree house damage is not too bad for their methods to fix it, or comparing the time required to travel two different paths). For *metacognition*,

the child had to refer to *knowing* as an awareness of mental processing (e.g., long numbers are hard to remember, remembering how you built something will help in fixing it, or imagining a race is different from actually racing). For *evaluation*, the child had to refer to *knowing* as determining the truth of a statement (e.g., whether someone will win a race or whether the fixed tree house will look even better).

Two coders independently scored all the tape-recorded answers. Their independent agreement was over 85% on the yes/no answer and the explanation answer for the six levels of meaning in the videotaped skits and audiotaped stories. The two coders were able to resolve these disagreements in most situations. This resulted in 96% agreement. The first author made a final judgment on the remaining 4% of situations.

On a third occasion, the 3- and 6-year-olds were administered the Peabody Picture Vocabulary Test (PPVT-R). The test records of the 9- and 12-year-olds were accessed, and their most recent standardized vocabulary measure was recorded.

Results

The results of the data analyses are presented in the following order. *First*, age and level of meaning differences in the average of the audiotaped stories and videotaped skits are presented using the *combined score* (yes/no plus explanation) as the dependent variable. We calculated separate analyses for the *explanation score* because the combined score may have been artifactually inflated due to a "yes" response bias. We also calculated separate analyses for the *yes/no score* because the combined score may have underestimated the child's knowledge for a variety of reasons: inability to verbalize response, shyness, and so forth. However, we do not provide the specifics of these analyses because they yielded essentially the same results as the combined score analyses. *Second*, the correlations involving the combined score with the standardized vocabulary measures are presented.

In order to determine the reliability of each of the six levels of meaning, Cronbach's alpha coefficient and item-total correlations were computed for all levels. As a rule, a reliability of alpha about .60 or greater is recommended for basic research (Nunnally, 1978). All levels of meaning, except *evaluation* (α = .27), were reliable based on this criterion. *Evaluation* was probably not reliable because of the difficulty of these questions. The percentage of correct answers for this level was very low for all age groups (see Table 1).

Age and Level of Meaning Differences

A 4 (Age [3-, 6-, 9-, 12-year-olds]) by 6 (Level of Meaning [perception, recognition, recall, understanding, metacognition, evaluation]) by 2 (Mode of Presentation [audio, visual]) ANOVA was computed to investigate developmental and level of meaning differences. Age was treated as a between-subjects factor, and Level of Meaning and Mode of Presentation were treated as within-subjects factors for all analyses presented in this report. It should be noted that the mean age of the 3-year-olds was closer to 4-year-olds (M = 3.96; SD = .30). This ANOVA analysis revealed significant main

Table 1. Means (and Standard Deviations) for the Combined Score (Yes/No plus Explanation) for the Levels of Meaning as a Function of Age

	Age Group			
Level of Meaning	3 years (N = 19)	6 years (N = 21)	9 years (N = 25)	12 years (N = 17)
Perception	2.78 (1.2)	3.91 (1.1)	4.86 (1.1)	5.18 (0.9)
Recognition	2.63 (1.4)	4.22 (1.3)	4.99 (0.9)	5.60 (0.6)
Recall	2.49 (1.2)	3.96 (1.2)	4.69 (1.2)	4.83 (1.0)
Understanding	2.60 (1.2)	4.34 (1.2)	5.01 (1.1)	5.46 (0.7)
Metacognition	2.26 (1.0)	3.45 (1.2)	4.15 (1.4)	4.68 (1.4)
Evaluation	1.43 (1.1)	1.71 (1.4)	1.74 (1.6)	1.86 (1.8)
Low	2.63 (1.2)	4.11 (2.6)	4.89 (1.1)	5.30 (0.8)
High	1.84 (1.1)	2.59 (1.5)	2.95 (1.9)	3.27 (2.2)
Total	2.40 (.45)	3.61 (.54)	4.24 (.48)	4.60 (.38)

Notes. Scores are means of individual performance means on a 6-point scale. Scores are the mean for the combined Mode of Presentation: audio plus video. Low Level of Meaning = Perception + Recognition + Recall + Understanding. High Level of Meaning = Metacognition + Evaluation. Total = all Levels of Meaning.

effects for Age, $F(3,79) = 150.73$, $p < .001$, Level of Meaning, $F(5,79) = 131.78$, $p < .001$, and Mode of Presentation, $F(1,79) = 62.88$, $p < .001$. There was also a significant Age by Level of Meaning interaction, $F(15,79) = 4.49$, $p < .001$ (see Figure 1). However, the Age by Mode of Presentation, $F(3,79) = 1.26$, $p > .25$, Level of Meaning by Mode of Presentation, $F(5,79) = 2.09$, $p > .06$, and Age by Level of Meaning by Mode of Presentation, $F(15,79) = 1.65$, $p > .05$, interactions were not significant. Table 1 displays the means and

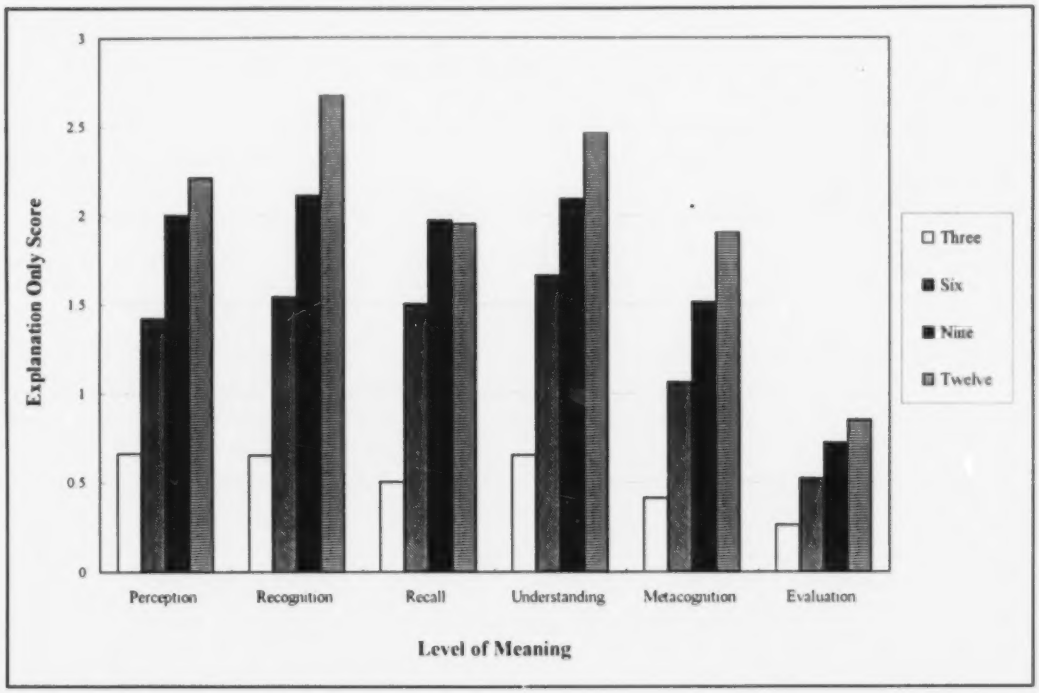

Figure 1. The Combined Scores (Yes/No plus Explanation) for the Six Levels of Meaning for the Combined Mode of Presentation (Audio plus Video) as a Function of Age

standard deviations for the six levels of meaning within each Age group. The video and audio modes of presentation are not reported separately because this variable did not interact with Age or Level of Meaning. There was only a main effect involving Mode of Presentation: video (M = 3.54) was answered correctly more often than the audio (M = 4.01). This was expected because the audiotaped stories were more conceptually demanding than the videotaped skits (see Appendices A and B).

Student Newman-Keuls comparisons ($\alpha < .05$) were calculated to unpack the significant Age by Level of Meaning interaction. This analysis revealed between-age differences on all levels of meaning except *evaluation*. Specifically, the 3-year-olds scored lower than all of the Age groups, and the 6-year-olds scored lower than the 9- and 12-year-olds on all levels of meaning except *evaluation*. In addition, the 9-year-olds scored lower than the 12-year-olds on *recognition*. This analysis

Table 2. Correlations Involving the Levels of Meaning of the Combined Score (Yes/No plus Explanation) with the Standardized Vocabulary Measures by Age

	Age Group			
Level of Meaning	3 years (N = 19)	6 years (N = 21)	9 years (N = 25)	12 years (N = 17)
		Audiotaped		
Low	-.26	.42*	.62***	.29
High	-.56*	.36	.37*	.21
Total	-.38	.49**	.62***	.41
		Videotaped		
Low	.30	.39*	.33	.33
High	.26	.05	.21	.53**
Total	.34	.44**	.37*	.53*
Overall	-.07	.54**	.61***	.64**

Notes. *$p < .10$, **$p < .05$, ***$p < .01$. See Table 1 notes.

also revealed within-age differences on Levels of Meaning. For the all Age groups, *evaluation* was lower than all other levels of meaning. For the 9-year-olds, *metacognition* was lower than all lower levels of meaning. For the 6- and 12-year-olds, *metacognition* was lower than *understanding* and *recognition*, and for the 12-year-olds *recall* was lower than *recognition*.

Since the post hoc differences reported above revealed that *evaluation* and *metacognition* were significantly lower than most of the other levels of meaning for most Age groups and since these scores showed the least improvement across Age, we combined these levels into a high Level of Meaning category, and combined the remaining levels into a low Level of Meaning category (see Table 1). We then calculated a 4 (Age [3-, 6-, 9-, and 12-year-olds]) by 2 (Level of Meaning [high, low]) by 2 (Mode of Presentation [audio, visual]) ANOVA. This analysis revealed a significant main effects for Age, $F(3,79) = 115.06$, $p < .001$, Level of Meaning, $F(1,79) = 312.90$, $p < .001$, and Mode of Presentation, $F(1,79) = 48.03$, $p < .01$. The Age by Mode of Presentation, $F(3,79) = 1{:}67$, $p > .40$, Level of Meaning by Mode of Presentation, $F(1,79) = 0.01$, $p > .90$, and Age by Level of Meaning by Mode of Presentation, $F(3,79) = 0.80$, $p > .40$, interactions were not significant. However, there was a significant Age by Level of Meaning interaction, $F(3,79) = 8.10$, $p < .001$. T-tests ($p < .01$) revealed that there were significant differences between low and high Level of Meaning for all Age groups. Student Newman-Keuls comparisons ($\alpha < .05$) revealed significant differences between all Age groups for low Level of Meaning.

There were less Age group differences for high Level of Meaning: 3-year-olds scored significantly lower than all other Age groups, and 6-year-olds scored significantly lower than the 12-year-olds.

Correlations between Cognitive Verb Knowledge and Standardized Vocabulary Measures

The correlations involving the audiotaped stories and the videotaped skits with the vocabulary measures are presented by Age group for the *combined scores* in Table 2. The audiotaped and videotaped overall correlation was significant for the 6-year-olds, $r = .54, p < .01$; for the 9-year-olds, $r = .61, p < .01$; and for the 12-year-olds, $r = .64, p < .01$; but not for the 3-year-olds, $r = -.07$. The correlations were probably not significant for the 3-year-olds due to floor effects on the audiotaped stories. The 3-year-olds scored very low on both low ($M = 2.49$) and high ($M = 1.57$) Level of Meaning for the combined scores.

Discussion

There were three important findings revealed by this investigation. *First*, the hierarchical knowledge of the cognitive verb *know* became more differentiated with development in that the 3-year-olds scored very low on all levels of meaning and showed the smallest number of Level of Meaning differences, whereas 12-year-olds showed the largest number of Level of Meaning differences. *Second*, cognitive verb knowledge of *know* increased with development; however, low Level of Meaning scores showed a larger increase over Age than high Level of Meaning scores. *Third*, the audio Mode of Presentation was more difficult than the video Mode of Presentation, but both measures correlated significantly with standardized vocabulary measures for all ages, except the 3-year-olds. The implications of each of these findings will be discussed in turn.

The present finding that children's knowledge of low Level of Meaning (*perception, recognition, recall, understanding*) was greater than high Level of Meaning (*metacognition, evaluation*) replicates an earlier pilot study in our laboratory with 3-, 6-, and 9-year-old children (Hughes, 1985), and extends previous studies which found that 4½-year-olds and their parents verbally produced certain low levels of meaning significantly more than certain high levels of meaning (Hall et al., 1987; Frank & Hall, 1991). All significant differences we found were in the direction predicted by our hierarchical model (see p. 4), but our study did not statistically differentiate between all the levels of meaning. Future research should address whether all six levels of meaning can be differentiated in *one* experiment.

This investigation shows that hierarchical cognitive verb knowledge tends to become more differentiated with age. We found that the 3-year-olds exhibited the smallest number of Level of Meaning differences; they scored reliably lower only on *evaluation*. This supports other studies which find that 3-year-olds have a very limited understanding of cognitive verbs (cf. Johnson & Wellman, 1980; Miscione et al., 1978). In contrast, older children in our study had more fine-grained distinctions between the hierarchical levels of meaning. For

example, the 12-year-olds scored lower on *evaluation* than all other levels of meaning, lower on *metacognition* than on *understanding* and *recognition*, and lower on *recall* than on *recognition*. The 6- and 9-year-olds revealed a moderate number of significant Level of Meaning differences. In fact, recent studies with older children also show that they distinguish between cognitive verbs that label subtle differences in internal mental states (Schwanenflugel, Fabricius, & Alexander, 1994; Schwanenflugel, Fabricius, Noyes et al., 1994).

Most importantly, the present study provides further support for recent models of the cognitive verb lexicon which suggest that internal state words are organized according to a continuum of internal processing or information manipulation (Booth & Hall, 1994c; Fabricius & Cavalier, 1989; Hall et al., 1987; Hughes, 1985; Miscione et al., 1978; Schwanenflugel, Fabricius, & Alexander, 1994; Schwanenflugel, Fabricius, Noyes et al., 1994; Wellman & Johnson, 1979). We suggest that the cognitive verb lexicon may be organized according to six levels of abstractness or conceptual difficulty. *Perception*, the most concrete level, describes sensory input that is immediately available to the observer; whereas *recognition* is a step removed from immediately available sensory input in that it relates this sensory input to past information merely to assess familiarity. *Recall* describes actual retrieval of past input, independent of immediate sensory input; whereas *understanding* represents a higher level of abstractness because it describes the semantic network to which knowledge is referred, thereby bringing to bear general knowledge rather than specific factual information as is the case in the preceding levels. These are the lower levels of meaning in this hierarchy. At the most abstract levels in this model, the child steps away from the act to report awareness of the process, not the product of thinking (*metacognition*); and s/he evaluates mental acts according to whether they imply true observations, contrary to fact propositions, or uncertain states (*evaluation*).

Our investigation revealed a significant Age by Level of Meaning interaction. Specifically, there was a greater number of Age differences on the low levels of meaning than on the high levels of meaning. In other words, children's knowledge of the low levels of meaning tended to increase at a faster rate than their knowledge of high levels of meaning (see Figure 1). Interestingly, Booth and Hall (1994b) found a significant Level of Meaning (low or high) by Age (fifth-grade, seventh-grade, tenth-grade, and college students) by Word-Frequency (low or high, based on Carroll, Davies, & Richman, 1971) interaction, and a significant Level of Meaning by Age by Cognate (*think* or *know*) interaction. Their results suggested that Level of Meaning differences for all cognitive verbs decreased with Age. Indeed, the mean difference in percent correct for low versus high levels of meaning was 17% for the fifth and seventh graders, but only 8% for the tenth graders and college students. Taken together, the Booth and Hall (1994b) study and the present investigation suggest that knowledge of low levels of meaning develops more rapidly than high levels of meaning from the preschool years until about the fifth grade, whereas knowledge of high levels of meaning develops more rapidly than low levels of

meaning from the fifth-grade through high school. This pattern probably results from the less abstract nature of and the less conceptual difficulty associated with the low as compared to the high levels of meaning. For example, it is less conceptually demanding to determine that a person is perceptually encoding or remembering something, than it is to determine how a person is reflecting on their cognitive operations or how they are evaluating whether something is true or not.

Our observed Age by Level of Meaning interaction was statistically the same for the audio and video Modes of Presentation. Since different methodologies revealed the same interaction, this suggests that this finding is robust and not a methodological artifact. The methodologies were in fact very different; the audiotaped stories were more difficult to comprehend than the videotaped skits. This difficulty difference is probably due to several factors. *First*, the videotaped skits were more motivating and appealing because they were viewed on TV, whereas the audiotaped stories were only accompanied by static schematic drawings. *Second*, the videotaped skits were much shorter than the audiotaped stories (i.e., the former were no more than three short sentences, whereas the latter were always at least six sentences). The longer audiotaped stories put greater demands on short-term and long-term memory. *Third*, each audiotaped story represented all six levels of meaning, whereas each videotaped skit represented only one level of meaning. *Fourth*, 11 questions were asked after the audiotaped stories, whereas only 1 two-part question was asked after the videotaped skits. The reason we employed both audiotaped stories and videotaped skits was to replicate any Age or Level of Meaning differences with two very different tasks and to ensure that we could test knowledge of cognitive verbs over a large age range.

This difference in difficulty between the audiotaped stories and videotaped skits explains the low percentage of correct explanations, even by the 12-year-olds. The 12-year-olds had over 80% correct explanations for the videotaped skits, but only 45% for the audiotaped stories, for all levels of meaning except *evaluation*. Again, the greater cognitive demands of the audiotaped stories may have caused this discrepancy. The relatively flat success rate for *evaluation* is more puzzling. It appears as though most children have not realized that you cannot predict the future with certainty (e.g., who will win a race or if a repair job will improve the appearance of a tree house).

Finally, we found that knowledge of cognitive verbs correlated significantly with standardized vocabulary measures for all Age groups, except the 3-year-olds. Indeed, research has revealed that knowledge of mental states and cognitive verbs is correlated with many other cognitive abilities, such as perspective-taking skills (Flavell, 1992) and metacognitive strategies (Booth & Hall, 1994a). The ability to distinguish between cognitive verbs, such as *think* and *know*, also seems to be correlated with many "theory of mind" tasks which require the ability to represent things in contradictory ways (cf. Flavell, Flavell, & Green, 1983; Gopnik & Astington, 1988; Wimmer & Perner, 1983). However, the investigation of children's developing understanding of mental state verbs provides additional insights into a

child's "theory of mind," because it allows an assessment of a child's understanding of the mental distinctions that these verbs represent. Many "theory of mind" tasks do not explicitly tap into children's conscious knowledge about how their minds operate. For this reason, the investigation of the cognitive verb lexicon seems to be particularly well suited to test theories about the development and organization of mental concepts in children as well as adults.

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Correspondence concerning this report should be addressed to William S. Hall, Department of Psychology, University of Maryland, College Park, Maryland 20742.

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Appendix A

The setting, tester prompts, and "correct" answers
for the six levels of meaning
for a selected six videotaped stories.

Perception Level

Setting: Jane on stage. John comes on stage and hugs Jane.
Tester: Does John know Jane is there?
Answer: Yes.
Tester: Why do you say that John knows (or doesn't know)?
Answer: John is touching Jane.

Recognition Level

Setting: John on stage, Jane offstage.
Jane: Today it's sunny.
John: I hear a voice. That's Jane.
Tester: Does John know the voice?
Answer: Yes.
Tester: Why do you say that John knows (or doesn't know)?
Answer: John has heard Jane's voice before.

Recall Level

Setting: John and Jane on stage.
Jane: Let's go to the movies.
John: Ok, it starts at 3.
Tester: Does John know when the movie starts?
Answer: Yes.
Tester: Why do you say that John knows (or doesn't know)?
Answer: John remembers it starts at 3.

Understanding Level

Setting: Jane, John, and a cardboard box with holes in it on stage.
John: My gerbil breathes air. The air comes in these holes.

Tester: Does John know how the air gets in?
Answer: Yes.
Tester: Why do you say that John knows (or doesn't know)?
Answer: John understands that air can travel through small holes.

Metacognition Level

Setting: John and Jane on stage.
Jane: I will teach you your phone number. Say 936–1212.
John: 9 . . . 3 . . . 6 . . . it is too much to remember.
Tester: Is there a lot for John to know?
Answer: Yes.
Tester: Why do you say that there is (not) a lot for John to know?
Answer: John cannot remember the phone number because it's too long.

Evaluation Level

Setting: Jane and John are on stage.
Jane: I am going to be in the race tomorrow.
John: You'll win!
Tester: Does John know Jane will win?
Answer: No.
Tester: Why do you say that John knows (or doesn't know)?
Answer: John cannot be sure that Jane will win.

Appendix B

The setting, tester prompts, and "correct" answers
for the six levels of meaning
for a selected two audiotaped stories.

The Tree House

(1) Kate and Chuck are playing in the woods behind their house. (2) They walk along the path that leads to the tree house they have built. (3) Kate says, "Oh no! Someone has been here, and one of the tree house walls is broken." (4) Kate and Chuck are angry. Chuck says, "It really doesn't look too bad. Maybe we can put it back together again." (5) Kate agrees with Chuck and says, "I think we will need a hammer, some nails, and a piece of wood to fix the wall." (6) Kate and Chuck agree that, when they are done fixing the wall, it will look even better than it did before.

Perception Level

Tester: Do the children know that the tree house wall is broken?
Answer: Yes.
Tester: How do they know?
Answer: They see it.

Recognition Level

Tester: Do the children know the tree house when they see it?
Answer: Yes.
Tester: How do they know?
Answer: They built it together behind their house.

Recall Level

Tester: Do the children know what the tree house used to look like?
Answer: Yes.
Tester: How do they know?
Answer: They know that the wall is now broken.

Understanding Level

Tester: Do the children know how to fix the tree house?
Answer: Yes.
Tester: How do they know?
Answer: They know that a hammer, some nails, and a piece of wood will be enough to fix it.

Metacognition Level

Tester: Does Kate know that a hammer, nails, and wood will help them fix the tree house?
Answer: Yes.
Tester: How does she know?
Answer: She can use the things she used to build the tree house.

Evaluation Level

Tester: Do the children know that the tree house will look even better than before?
Answer: No.
Tester: How come they do not know?
Answer: Something may go wrong or the damage may be irreversible.

A Trip to the Swimming Pool

(1) It is a beautiful, hot day. So Marla and Jackie are going to go swimming at the pool. (2) Marla meets Jackie and says, "Hi! Are you ready to go swimming?" Jackie says, "Marla, follow me, I know a shortcut to the pool." (3) Marla tries to remember if she has ever gone this way to the pool before. She tells Jackie that she doesn't know where they are. (4) Jackie says to Marla, "Look, the pool is right over there. Now you can see how fast my shortcut is?" (5) Marla pretends that she and Jackie race to the pool and jump right into the cool water. (6) Marla says, "Let's race to see who gets to the pool first." Jackie says, "Okay, but I know who will win the race."

Perception Level

Tester: Do the children know it is a good day to go swimming?
Answer: Yes.
Tester: How do they know?
Answer: They feel it is a hot day.

Recognition Level

Tester: Does Marla know the shortcut Jackie takes her on?
Answer: No.
Tester: How come she does not know?.
Answer: Marla does not remember going that way, and she does not know where they are.

Recall Level

Tester: Does Marla know how to get to the pool?
Answer: Yes.
Tester: How does she know?
Answer: She has gotten there before. She is just not familiar with the shortcut.

Understanding Level

Tester: Do the girls know that taking a shortcut got them to the pool quicker?
Answer: Yes.
Tester: How do they know?
Answer: They compare the times after they arrive at the pool.

Metacognition Level

Tester: Does Marla know that she must ask Jackie in order to actually race her?
Answer: Yes.
Tester: How does she know?
Answer: First she pretends, then she asks to race.

Evaluation Level

Tester: Does Jackie know who will win the race to the pool?
Answer: No.
Tester: How come she does not know?
Answer: She may have a good idea, but she doesn't know for sure.

[redacted]

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NRRC National Reading Research Center

318 Aderhold, University of Georgia, Athens, Georgia 30602-7125
3216 J. M. Patterson Building, University of Maryland, College Park, MD 20742